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ABSTRACT

Studies of children's representation of spatial relationships and ability to respond to temporal relationships in photographs are reported. Participants in the study of spatial relationships were 90 children at 5, 8, and 11 years of age, who were asked to reproduce three types of depth relationship: enclosure, occlusion, and perspective. Each child was assigned to either a drawing or a photographic condition. Results revealed that the particular type of spatial relationship had an effect on the children's ability to make accurate reproductions and that this effect varied in the drawing and photographic conditions. Data further indicated that children's representations of spatial relationships are closely tied to the particular media of representation. In the study of temporal relationships in photographs, participants were 96 children at 7 and 11 years of age, who responded to a series of eight photographs depicting a variety of subject matter. Recorded interviews were analyzed for changes in tense, the adverbials "before" and "after," and for any mention of past or future circumstances that could surround the photographs. All subjects made some reference to time during the interviews; however, they were most concerned with discussing the present situation and the appearance of the photos. Statements referring to temporal relationships were grouped in categories concerning actions, events, spatial transformations, or the photographic medium. The finding that types of responses varied among photographs suggests that concerns about time can become part of what is represented in static, atemporal symbols. Findings are interpreted in terms of Werner and Kaplan's (1963) approach to the problem of representation. (RH)

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Children's representations of spatial and temporal relations

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Since the "Cognitive Revolution" of the 1950's and 60's there has been a renewed interest in the problem of representation. In order to talk about the organization of information, thought and the development of thought, it has become necessary to determine how information is represented in the mind. Despite this recent interest, the problem has had a long history. Perhaps its clearest formulation can be found in the writings of Descartes. However, psychological theories have typically treated the problem as a simple matter, and have assumed that what is represented is merely a reflection of objects and events in the natural surroundings. In this sense, what is represented is simply a re-presentation or "sign" of what occurred or is present. Thus, a child's images, words, stories and thoughts are primarily representations of the child's experiences. While this solution may seem feasible for explaining simple objects or well defined events, it has serious shortcomings when forced to explain the representation of more complex information or thoughts. For example, time and space are intuitive dimensions of all experiences; however, there are no single experiences which define the essence of these dimensions, nor are there senses analogous to vision or hearing that could organize either temporal or spatial relationships. It seems impossible to explain the representation of time and space as a simple derivative of experience.

Piaget (1969; Piaget & Inhelder, 1956) has pointed out the importance of distinguishing between the experience of time and space and the representation of time and space as conceptual entities. While infants and young children demonstrate an intuitive sense of time and space in practical activity, older children demonstrate flexible, invariant conceptualizations of temporal and

spatial relationships that transcend any particular activity or experience. For Piaget, these conceptual representations are not derived from direct experience but rather are a result of the unfolding pattern of intellectual activities or operations. In this sense, a child's images, words, stories and thoughts are symbols that represent what the child is capable of knowing in terms of operative activities. Here the significance of a symbolic representation is determined by what could be known and not merely by what is given from the surroundings.

While the Empiricist's account and Piaget's brand of Idealism depict two extreme resolutions to the problem of representation, both approaches share several features and difficulties. First, both approaches separate the specific forms of representation from their significance. What is represented in any symbolic form gets its authority and meaning from what has already been firmly established in either experience or intellectual achievement. However, it is possible and quite common to explore through images, words, stories and thoughts experiences that have not been had and ideas that are not fully understood. A second feature of both approaches concerns the uni-directional function of representation. In both approaches either experience or knowledge determines what is represented but neither approach allows an understanding of the way in which the acts of representing influence what is experienced or known. Representations in different symbolic forms provide very different experiences and can alter the status of understanding.

Werner and Kaplan (1963) provide a third approach to the problem of representation that addresses these difficulties. For Werner and Kaplan, symbolic representations are not merely a reflection of either experience or intellect but rather are autonomous entities that "... enable the realization

of those operations constituting the activity of knowing." Symbolic representations achieve their significance from the interweaving of the symbolic media with the referential meaning. The way in which the medium and its message come together is referred to as the "process of dynamic schematization". This process is defined as the correlative twin building process that establishes both the symbolic medium as well as the referent itself into a symbolic form. The symbol is intimately tied to this form building process throughout its existence. If the bond between the symbol and the process is not established or if it is broken at any time, meaning is lost. Here the symbol is fused with its significance and the unique meaning of the symbol is reciprocally determined by both the symbolic medium and the intended referential meaning. This paper will present two studies which suggest the importance of considering this form building process and the interweaving of symbolic media and referential meaning.

The first study is concerned with children's representation of spatial relationships. Ninety children, ages five-, eight- and eleven-years, were asked to reproduce three types of depth relationships: Enclosure - where one larger object is located directly behind a smaller object, Occlusion - where one object is located in front of and partially obscuring another object, and Perspective - where two objects are completely in view but one is located behind and at a distance from the other. Examples of these relationships can be seen in Figure 1. Half of the children in each of the age groups were randomly assigned to either a Drawing condition, in which the children were asked to reproduce line drawings of the relationships, or a Photographic condition, in which the children reproduced the relationships using a Polaroid camera.

In order to determine the children's ability to identify the spatial

relationships a matching task was administered prior to the reproduction task. Each child was presented with a standard picture depicting one of the three relationships and was asked to match the standard to an identical picture from an array of four pictures. There were nine such tasks in which each of the three relationships were presented three times with different objects. The children in the Drawing condition performed the matching task using drawings and the children in the Photographic condition performed the task with photographs. The children were capable of discriminating and identifying the various relationships at all three age levels in both conditions. However, performance was slightly better for the five-year-olds in the Drawing condition.

Approximately a week after the matching task was given each child was individually brought to a play area where two large containers were located. One container was approximately one foot smaller in height and width than the other. The containers were placed eight feet apart. The child was taken to the center of the play area, between the two containers, and shown either a drawing or photograph depicting the two containers in one of the depth relationships. The child was then asked to make a picture that was "just like" the one that was presented. After the first attempt at making a reproduction, the child was given the opportunity to compare his or her reproduction with the original and make a second reproduction. The child was then asked to choose which reproduction was best. This procedure was repeated for each of the three depth relationships. In the Photographic condition the children were presented with photographs of the relationships and were given a Polaroid camera. Prior to presenting the photographs each child was given instructions in using the camera and were allowed to take one practice picture. In the Drawing condition the children were provided with a pad of paper and a marker.

The children's "best" reproductions were scored accurate or inaccurate by two independent judges, achieving a reliability coefficient of .87. A three way repeated measures ANOVA (Age by Condition by Type of Relationship) indicated that the number of accurate reproductions increased with age, and that there were significantly more accurate reproductions in the Drawing condition than in the Photographic condition. Post hoc comparisons revealed significant differences in performance between Drawing and Photographic conditions for the five- and eight-years olds, while the eleven-year-olds' performance was equivalent in the two conditions.

Most importantly, the results revealed that the particular type of spatial relationship had an effect on the children's ability to make accurate reproductions, and that this effect varied in the Drawing and Photographic conditions. It can be seen in Table 1 that in the Drawing condition the five- and eight-year olds produced more accurate reproductions of the enclosed and occluded relationships than they did of the perspective relationship. Furthermore, the children made significantly more repeated attempts at reproducing the drawing in perspective than they did of the other two relationships. However, in the Photographic condition the five- and eight-year-olds did not produce as many accurate reproductions of the enclosed and occluded relationships, and were more successful in reproducing the photograph of the perspective relationship. Also, the children in this condition made more repeated attempts to reproduce the enclosed and occluded relationships than they did of perspective.

These data indicate that children's representation of spatial relationships are closely tied to the particular media of representation. Overall, it was easier for the children to represent space in drawings than in photographs, and further, specific kinds of relationships were easier to represent in one

medium than in the other. When drawing the children could easily reproduce the enclosed and occluded relationships, and had difficulty reproducing the drawings in perspective. When taking photographs the children could easily reproduce the perspective relationship but had difficulty reproducing the enclosed and occluded relationships. While it is awkward to explain this variation as a result of experience with the environment or as a result of differences in conceptual understanding, an explanation is possible by considering the specific dynamic activities involved in drawing and in taking a photograph.

The chirographic aspect of drawing influenced the way in which the children utilize spatial characteristics when making a reproduction. It was possible for the children to draw an accurate reproduction with only an overview of the spatial relationships. The children did not have to continually examine and move around the containers while making their drawings, and they did not have to establish a fixed station point between themselves and the containers. Drawing the enclosed and occluded relationships was simply a matter of drawing one shape on top of another. Drawing objects in perspective was not as clearly defined in terms of the lines the children had to draw. On the other hand, reproducing the relationships in photographs required different types of spatial activities. The children had to move around and examine the containers in order to establish a fixed station point before making a reproduction. In doing so, perspective was reproduced without effort; however, reproducing the enclosed and occluded relationships required that the children align themselves so that the containers would appear to overlap in the photograph. It appears that the quality of spatial experience and the complexity of spatial relationships are mediated by the activities inherent in the media of representation, and become part of what children know.

Implicit in Werner and Kaplan's theory of symbol formation is the notion that changes and activities that occur over time are an essential part of any symbolic representation. The significance of a symbol is not found in its static configuration but rather ~~is~~ resonating in the temporal activities that have brought about its prescence. To interpret a symbol is to respond to some form of action that may have gone into its make up. This aspect of Werner and Kaplan's theory is nicely demonstrated by language. The meaning of a word or phrase is informed by the discourse it is embedded in. Borrowing the Humboltian notion of language as "energeia", Werner and Kaplan stress that language is experienced and known by its actions and not by its structural properties. However, nonverbal symbols, such as images and pictures, seem to be devoid of time and action; representing instead frozen moments. The second study is a preliminary investigation concerned with children's ability to respond to temporal relationships in photographs. Ninety-six children, ages seven and eleven-years, were asked to respond to a series of eight photographs during the course of an open ended interview. The photographs depicted a variety of subject matter. During the interview the children were asked several general questions, such as: "What is this?", "Is this real?", "Do you like (or dislike) this and why?". The interviews lasted approximately twenty minutes and were voice recorded.

The protocols were transcribed and analyzed for changes in tense, the adverbials "before" and "after", and for any mention of past or future circumstances that could surround the photographs. It was found that all of the children made some reference to time during the interviews; however, they were most concerned with discussing the present situation and the appearance of the photographs. An average of only 10 statements per child were identified as making reference to some type of temporal relationship. These statements were grouped into four categories. The first category represents statements that

referred to Actions, in which the children described the temporal activities depicted in the photographs. The second category was composed of statements that referred to the time of an Event or situation either depicted in the photograph or implicit in the taking of the photograph. The third category of responses described time in terms of Spatial transformations implied in the photographs. And the fourth category included responses that made reference to time by discussing the photographic Medium. There were no significant differences between the seven- and eleven-year-olds use of the different categories of response; however, the types of responses did vary among the particular photographs. A breakdown by category and photographs is presented in Table 2.

(Six photographs will be presented and examples of the responses will be read)

These findings suggest that concerns about time can become part of what is represented in static, atemporal symbols. This seems to be more true of some photographs than of others. There was a clustering of temporal responses for three of the photographs (The Octopus, Swirls and Eddies of a Tennis Stroke and The Kiss of Peace). It may be that the particular way in which these photographs are disorienting elicits doubts about how the depiction of the subject matter occurred in time. How the children expressed these doubts seems to have varied across the four types of response. The children's discussions were not limited to configural patterns or the visual information presented in the print, but included, to some degree, a concern with the process of construction. However, their discussions of this process were not restricted to any particular time sequence or constructive act. The children's concerns with time were expressed in their discussions of depicted action, the context of an event, spatial transformations and the use of the medium itself.

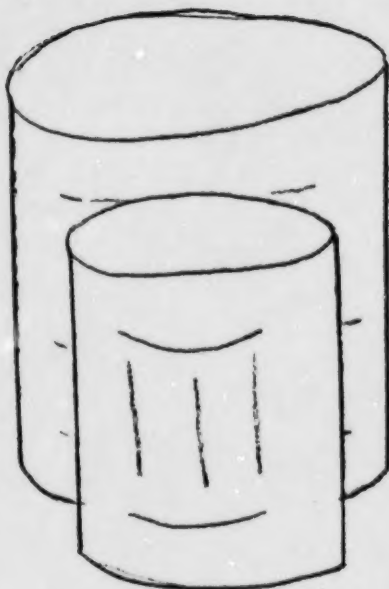
Taken together these two studies demonstrate the importance of constructive process in the production and interpretation of symbolic representations. This in itself is not new. Information Processing approaches to the study of cognition have been a proponent of such a view; and despite the early claim to Structuralism, Piagetian research has become more concerned with the process of knowing. However, from Werner and Kaplan's orientation the plea for considering the formative process in understanding symbolic representations is markedly different. Here the formative process is of primary importance. Symbols develop and emerge over time and the specific aspects of the temporal process of becoming is the central component of what is significant in symbols. Any attempt to reduce or explain the formative process by way of a descriptive formalism or by a structural principle would be suspect. From this orientation symbolic representations are not explained away, but rather the task instead becomes one of understanding the intentions and dynamics of human achievement.

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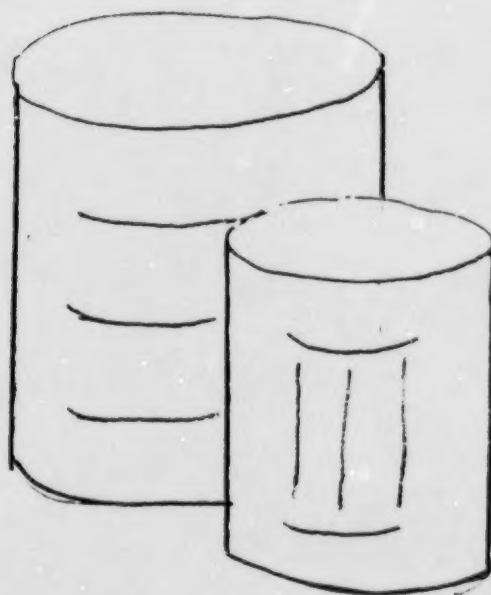
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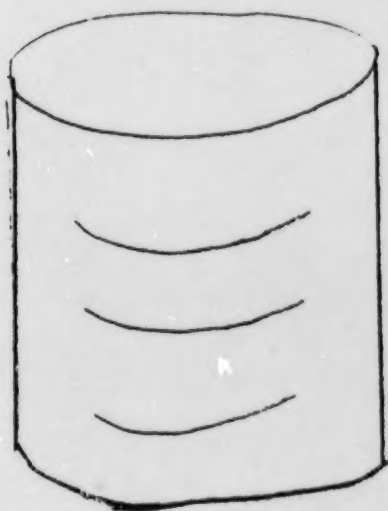
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ENCLOSURE



OCCLUSION



PERSPECTIVE



Percentage of Accurate Reproductions Presented by
Age, Condition and Type of Spatial Relationship.^a

<u>AGE</u>	<u>DRAWING CONDITION</u>			<u>PHOTOGRAPHIC CONDITION</u>		
	<u>ENCLOSURE</u>	<u>OCCCLUSION</u>	<u>PERSPECTIVE</u>	<u>ENCLOSURE</u>	<u>OCCCLUSION</u>	<u>PERSPECTIVE</u>
5	46	40	13	20	13	60
8	80	60	33	33	26	73
11	100	100	86	86	73	93

^aPercentages based on 15 reproductions per cell

Percentage of Temporal Responses Presented by
Type of Response and Photographs.^a

<u>PHOTOGRAPHS</u>	<u>TYPE OF RESPONSE</u>				<u>TOTAL</u>
	<u>ACTIONS</u>	<u>EVENTS</u>	<u>SPATIAL</u>	<u>MEDIA</u>	
EXPLOSION OF THE HINDENBURG	3 (30)	7 (72)	—	—	10 (102)
CANYON DE CHELLY	3 (32)	2 (21)	—	—	5 (53)
TOWN HALL	2 (20)	—	5 (51)	1 (11)	8 (82)
MONO LAKE	2 (20)	—	3 (31)	2 (22)	7 (53)
THE OCTOPUS	6 (60)	9 (94)	3 (28)	5 (52)	24(234)
SWIRLS AND EDDIES OF A TENNIS STROKE	5 (49)	—	9 (92)	4 (40)	18 (181)
THE KISS OF PEACE	—	9 (87)	—	8 (82)	17 (169)
CHILD IN FOREST	7 (69)	3 (27)	—	2 (19)	12 (115)

^a Frequencies are presented in parentheses